IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Eric Erike
Serial No.	:	10/726,961
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For	:	METHOD OF PRODUCING A COLD TEMPERATURE HIGH TOUGNESS STRUCTURAL STEEL TUBING
Group Art Unit	:	1742
Examiner	:	Kathleen Mcnelis
Attorney Docket No.	:	TRW(VSSIM)5875-1

Commissioner for Patents
P.O. Box 1450
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DECLARATION UNDER 37 CFR §1.132

Sir:

I, Eric Erike, declare as follows:

1. I am the inventor of the patent application entitled "METHOD OF PRODUCING A COLD TEMPERATURE HIGH TOUGNESS STRUCTURAL STEEL TUBING", disclosed and claimed in U.S. Application Serial No. 10/726,961 filed December 3, 2003.

2. I obtained my bachelor of science in engineering from the State University of New York, Stony Brook, NY, Master of Science in materials engineering from the State University of New York, Stony Brook, NY, and completed Doctorate course work in engineered materials from Arizona State University, Tempe, AZ.

3. I have worked at TRW Vehicle Safety Systems, Mesa, AZ, from 1987 to the present, as a staff engineer, project engineer, senior project engineer, senior staff engineer, and senior technical specialist. In September 1998, I was honored with the Technical Fellows award from TRW automotive. In June 2002, I was honored with the Chairman's Award for innovation from TRW automotive. My publication include: "Clean steel practices used in development of automotive airbag components", Society of Materials Engineers, Clean Steel Practices for Stainless Steel Manufacturing Clinic, January 2-6, 1995.

4. It is common knowledge that steels exhibit a ductile-to-brittle fracture transition at low temperatures. The ductile-to-brittle fracture transition is a marked change in fracture resistance of steel with changes in one or more test variables. It occurs only in certain steels within ranges that depend on the steel. Temperature, stress state, and strain rate are among the variables that can give rise to fracture transition.

5. It common knowledge that a Charpy V-notch impact test is the most commonly used international test for studying fracture-transition behavior. In the Charpy V-notch test, steel specimens are provided with a sharp notch and tested under impact (high strain rate). The transition temperature from ductile (i.e., plastic fracture) to brittle fracture can be calculated using this test as the maximum temperature of brittle area outbreak. The maximum temperature of brittle area outbreak is calculated as a function of shear area ratio and temperature. At temperatures above the maximum temperature of brittle area outbreak, tested steels display significant plasticity and exhibit ductile behavior. At temperatures below the maximum temperature of brittle area outbreak, steels behave in a brittle glass-like manner.

6. I developed seamless tubes for stored gas inflators using low-carbon steels. A first generation of seamless tubes were formed by casting known low-carbon steels into billets, hot-rolling and piercing the low-carbon steels to form a seamless tube, and then quench tempering and cold drawing the low-carbon steel tubes.

7. I developed a second generation of seamless tubes in which the composition or chemistry of the low-carbon steel was optimized to substantially increase the tensile strength and minimize stress corrosion cracking of the low-carbon steel. The optimized composition of the low-carbon steel is disclosed and claimed in U.S. Patent No.6,386,563 and consists essentially of, by weight, about 0.07% to about 0.12% carbon, about 0.7% to about 1.60% manganese, up to about 0.020% phosphorous, up to about 0.015% sulfur, about 0.06% to about 0.35% silicon, about 0.25% to about 1.20% chromium, up to about 0.65% nickel, about 0.20% to about 0.70% molybdenum, up to about 0.35% copper, about 0.02% to about 0.06% aluminum, up to about 0.05% vanadium, up to about 0.25% residual elements, and the balance iron. The second generation of seamless tubes were formed using a similar process as the first generation of seamless in which cast billets of the low-carbon steel were hot rolled, pierced, quench tempered, and then cold drawn. The optimized composition of the second generation of seamless tubes, however, resulted in an increase in cold transition temperature.

8. I developed a third generation of seamless tubes that had the same composition as the second generation of seamless tubes but were formed by different processes to improve the cold transition temperature and microstructure of the seamless tube. The third generation of seamless tubes were formed by casting, hot rolling, piercing, cold drawing, and then heat treating the low-carbon steel. The heat treating process

included either (1) annealing and then quench tempering the cold drawn tube using a standard electric gas or gas furnace or (2) induction heating the cold drawn tube. The steel of the third generation seamless tubes formed by the induction heat treatment process had an improved tensile strength compared to the steel of the first generation seamless tubes and a substantially improved cold transition temperature compared to the steel of first generation and second generation seamless tubes and the steel of the third generation seamless tubes formed by annealing an quench tempering using a standard furnace.

9. Experiments were performed comparing the maximum temperature of brittle area outbreak and tensile strength for examples (Ex. 1-3) of low-carbon steels having similar compositions but processed into seamless tubes using different processes. The results are plotted in the attached graph. For each of the examples 1-3, the low-carbon steel used to form the seamless tubes consisted essentially of, by weight, about 0.07% to about 0.12% carbon, about 0.7% to about 1.60% manganese, up to about 0.020% phosphorous, up to about 0.015% sulfur, about 0.06% to about 0.35% silicon, about 0.25% to about 1.20% chromium, up to about 0.65% nickel, about 0.20% to about 0.70% molybdenum, up to about 0.35% copper, about 0.02% to about 0.06% aluminum, up to about 0.05% vanadium, up to about 0.25% residual elements, and the balance iron. The maximum temperature of brittle area outbreak was determined using a Charpy V-impact test on steel samples obtained from seamless low carbon steel tubes formed by the different processes. The tensile strength of steel samples obtained from seamless low carbon steel tubes formed by the different processes was measured in accordance with ASTM E8/E8M. In each of examples 1-3, the low carbon steel was cast, hot rolled to form a cylindrical billet, and then pierced to form a tube. The low carbon steel tube of

example 1 was then quench tempered to a temperature of about 620°C and then cold drawn to form a seamless tube. The low carbon steel tube of example 2, after piercing, was cold drawn and quench tempered to a temperature of about 520°C. The low carbon steel tube of example 3, after piercing, was cold drawn and then induction heated to a temperature of about 520°C.

10. The low-carbon steel of example 1 had a tensile strength of about 925 N/mm2 and maximum temperature of brittle area outbreak of about -20°C. The low-carbon steel of example 1 had a tensile strength of about 912 N/mm2 and maximum temperature of brittle area outbreak of about -80°C. The low-carbon steel of example 1 had a tensile strength of about 925 N/mm2 and maximum temperature of brittle area outbreak of about -105°C.

11. The low carbon steel of example 3, which was heat treated by induction heating, exhibited a remarkable improvement in maximum temperature of brittle area outbreak compared to the low carbon steel of examples 1 and 2 remaining ductile and plastic at temperatures below -100°C.

12. Based on my experience in low carbon steel engineering and seamless tube fabrication as well as my review of low-carbon steel and seamless tube fabrication literature, a low-carbon steel having plasticity down to about -100°C has previously not been formed. Additionally, based on my experience in low carbon steel engineering and seamless tube fabrication, it would not be reasonable to expect that an low carbon steel heat treated by an induction heating process would out perform the same material produced with gas or electric furnace heat treatment process.

13. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Eric Erike

Date: 9/22/06